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Selecting an Appropriate Operationalization of the System Usage Construct: An IT Artifact Perspective

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ABSTRACT

This paper aims at promoting more systematic information systems (IS) usage research. It suggests that there is a link between the operationalization of the system usage construct and the researchers' view of the information technology (IT) artifact in a particular research. We suggest that in order to get an appropriate operationalization of the system usage construct, the richness of the measure should correspond to the chosen conceptualization of the IT artifact. Using extant IS literature, we performed an exploratory analysis of a sample of studies to better understand the relationship between these two concepts and showed how the fit could sometimes be improved. In conclusion, we discuss the implications of this study for future research.

Keywords

IS use, System usage, IT artifact, Use measure.

INTRODUCTION

In order to improve the accumulation of knowledge, researchers have recently called for a better conceptualization of existing constructs in the information systems (IS) field (e.g., Barki, 2008). Since system usage is one of the key constructs in IS research, researchers are constantly interested in reconceptualizing and developing better measures for this construct (Benbasat and Zmud, 2003; Delone and McLean, 1992). Burton-Jones and Straub (2006) propose a systematic approach to conceptualize the system usage construct. Their approach includes defining the usage construct and then selecting the appropriate structure of measure (including user, system, and task elements). They further suggest that the choice of structure of the measure for the system usage construct is contingent upon the particular research objective, theory and methods (p.232).

Following Burton-Jones and Straub (2006), we argue that researchers could use different structures for measure of system usage in different studies. We believe that the identification of the factors that influence the choice of a system usage measure represents an important step towards more systematic research in the field of IS. Therefore, the general research question of our study is: "What are the factors that influence the structure of measure of the system usage construct"?

To provide a partial answer to this question, we build on the seminal work of Orlikowski and Iacono (2001). They showed that researchers might adopt different perspectives vis-à-vis the IT artifact. We suggest that one of the most influential factors that should be taken into account in the operationalization of the system usage construct in a particular study is the researcher's view of the IT artifact. In other words, our central argument is that structural elements of the system usage measure differ along various conceptualizations of the IT artifact. More specifically, we argue that each perspective to IT artifact (nominal, tool, proxy, computational, ensemble) is related to a specific structure for system usage measure (very lean, lean, somewhat rich, rich, very rich).

To better understand the IT artifact-system usage measure relationship, we use a three-year update of the classification of Orlikowski and Iacono (2001) that was performed by Akhlaghpour et al (2009). We do not test the suggested relationship. Rather, we explore and discuss how some of the studies in our sample could be improved by considering the proposed fit.

The contributions of this study are twofold. First, we suggest how different views of the IT artifact and operationalization of the system usage construct could be related. Second, we extend the work of Burton-Jones and Straub (2006) by taking a step further towards a more systematic approach to selecting and/or developing system usage measures.

BACKGROUND

Need for a Cumulative Research Tradition

The IS field suffers from the lack of integration of its research on concepts such as system usage (Benbasat and Barki, 2007). As a consequence, knowledge is accumulating slowly. It thus becomes important for researchers to build upon existing studies. Regarding this problem, Barki (2008) calls for developing existing constructs and defining better measures for them. Barki states that "conceptualization and measurement of constructs provide many opportunities for contributing to information systems research and practice by providing a better understanding and explanation of interesting and important phenomena" (p.9). Barki specifically uses the system usage construct as an example of a construct that has suffered from narrow definitions for a long time. Therefore, he calls for more work on its alternative reconceptualization and measurement (p.15).

System Usage Construct

The system usage construct has received a lot of attention in IS research (Benbasat and Barki, 2007, Burton-Jones and Straub 2006; Benbasat and Zmud, 2003; Delone and McLean, 1992; Doll and Torkzadeh 1998; Straub et al. 1995). The seminal work of Delone and McLean (1992) includes system "use" as one of the key variables in the IS field. Since system usage is a broad concept, it can be viewed from several perspectives (Delone and McLean, 1992). In a recent study, Burton-Jones and Straub (2006) propose a new conceptualization of the system usage construct. They define the individual-level system usage as "an individual user's employment of one or more features of a system to perform a task" (p.231). According to Burton-Jones and Straub (2004), the structure of the system usage construct comprises three elements: the user, the system, and the task as illustrated in Figure 1.

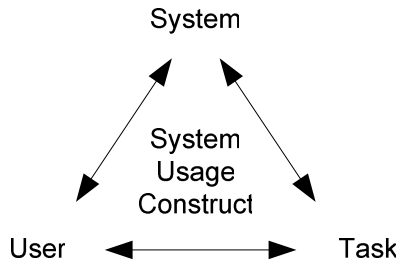

Figure 1. Three elements of system usage construct, as suggested by Burton-Jones and Straub (2006)

Burton-Jones and Gallivan (2007) explain this three-element structure as follows:

"researchers could measure system usage in a user-centered fashion (measuring users' cognition during use), in a system-centered fashion (measuring IS features used), in a task-centered fashion (measuring tasks for which the IS is used), or in a more holistic fashion" (p.659)

Burton-Jones and Straub (2006) note that the conceptualization and operationalization of this construct may differ across studies. Therefore, they propose a two-stage systematic approach to reconceptualize and operationalize the system usage construct for a particular research. These stages are, respectively, definition of the usage construct and measure development. The former stage focuses on defining the distinguishing characteristics of system usage and stating the assumptions regarding these characteristics. The latter stage, however, focuses on choosing the best measures for the part of the usage activity of interest. Since our objective in this paper is helping to select relevant measures for system usage construct, we will focus on the second stage of this approach.

Burton-Jones and Straub (2006) suggest that the second stage, that is the selection of a measure, includes choosing the structure of the measure (which elements are relevant for a given study?) and the function of the measure (how is it possible to operationalize these elements?). Depending on the inclusion or exclusion of any of the three elements, the measure of system usage can range from very lean to very rich (see Appendix A). At one extreme, very lean measures only take into account the "presence of use" (p.233). For example, a very lean operationalization might measure usage as a dichotomous variable of use/non-use. At the opposite end of the spectrum, very rich measures of usage will take into account the "extent to

which the user employs the system to carry out the task" (Burton-Jones and Straub, 2006, p.233). A very rich operationalization might measure the cognitive state of a user while performing a task with a system.

Identifying the three dimensions of the system usage construct has been a very important step towards more systematic research in the IT acceptance and use field. Another important step, however, is to identify when and under what contingencies each measure of system usage is relevant and appropriate. Burton-Jones and Straub (2006, p.232) propose that the choice of structure of the measure for the system usage construct is contingent on the objective, theory and methods of a particular research. We aim to explore and identify such contingencies that could drive the choice of structure of measures. In the following sections, we will develop our arguments to show that one important factor that should be considered in deciding about the structure of the system usage measure in a particular study is the researcher's perspective vis-à-vis the IT artifact (Orlikowski and Iacono, 2001).

IT Artifact Perspectives

Benbasat and Zmud (2003) suggest that the IT artifact is at the core of IS research. They conceptualize the IT artifact "as the application of IT to enable or support some task(s) embedded within a structure(s) that itself is embedded within a context(s)" (p.186) and argue that any IS research should consider the IT artifact. Therefore, measuring the way such enabling or supporting applications of IT are performed (i.e., usage operationalization) in an appropriate way could depend on the *type* of IT artifact (e.g., ERP, DSS).

To the best of our knowledge, only a few typologies of IT artifacts exist in the literature. In general, these studies classify an IT based on its technical aspects, locus of operation, or functions. For instance, ITs have been classified by the level of corporate hierarchy in which they are used (Lauden et al., 2006). Doll and Torkzadeh (1998) classified ITs based on three functions: decision support, work integration and customer service.

While the abovementioned classifications mostly focus on the technical and functional aspects of a technology, the seminal work of Orlikowski and Iacono (2001) emphasizes the need to pay closer attention to the IT artifact in IS research and shows that only a fraction of IS scholars view the IT from such a *tool* perspective. The implication of their research for our study is that a classification of IT solely based on its technical aspects, locus of operation, or functions cannot significantly help to explain the variations in system usage measures or guide the choice of measure. Based on a thorough analysis of the extant literature, Orlikowski and Iacono identify five different conceptualizations of the IT artifact:

1) IT can be conceptualized as a *tool*. According to this viewpoint, IT is "the engineered artifact, expected to do what its designers intend it to do" (Orlikowski and Iacono, 2001, p.123).

2) Some researchers adopt the *proxy* perspective to IT artifact and "focus on one or a few key elements in common that are understood to represent or stand for the essential aspect, property, or value of the information technology" (p.124).

3) Seeking for a richer perspective to IT, some researchers who "have been dissatisfied with the *tool* and *proxy* views of technology" (p.125) view IT from an *ensemble* perspective. Studies from this perspective focus on "the dynamic interactions between people and technology" (p.126).

4) IT may be defined based on its *computational* capabilities. Researchers adopting this point of view are interested in "the capabilities of the technology to represent, manipulate, store, retrieve, and transmit information, thereby supporting, processing, modeling, or simulating aspects of the world" (p.127).

5) In the last perspective, called *nominal*, the IT artifact is actually "absent" (p.128) and the researcher uses it simply as background information.

It is important to note that these perspectives are generally uncorrelated with the actual *type* of the IT system. According to Orlikowski and Iacono (2001), a given technology could be viewed differently by different researchers. For example, an ERP could be viewed as a system that enables the organization to be more efficient in using resources (*tool* view). Alternatively, it could be seen as a system that affects the work style of the employees, the organizational processes and the organization structure (*ensemble* view).

Given these additional insights, we develop further our preliminary argument by replacing the *type* of IT artifact with the *view adopted by the researcher vis-à-vis* the IT artifact. We argue that different perspectives will be associated to differences in how usage is conceived and measured and thus, one of the important characteristics of an IS research that influences the structure of system usage construct operationalization is the perspective adopted by the researchers with regards to the IT artifact.

LINKING SYSTEM USAGE MEASUREMENT TO PERSPECTIVE TO THE IT ARTIFACT

In this section, we put forward more specific arguments regarding the potential link between the IT artifact conceptualization (Orlikowski and Iacono, 2001; Akhlaghpour et al. 2009) and system usage measures (Burton-Jones and Straub, 2006). Therefore, we bridge the two research streams of system usage operationalization and theorizing the IT artifact as follows:

First, from the *tool* perspective, IT is designed to perform tasks such as labor substitution, productivity, information processing, and social relations (Orlikowski and Iacono, 2001). These categories are conceptually similar to the IT functions classification proposed by Doll and Torkzadeh (1998). We argue that since the *tool* view assumes that the system is designed to do a task, a proper measure of system usage construct should here comprise both the "system" and "task" elements. Consequently, a research from this perspective would generally require a "rich" operationalization of the system usage construct.

The second IT artifact view, *proxy*, is somewhat challenging. According to Orlikowski and Iacono (2001), this view supposes that the critical aspects of IT can be captured through some set of surrogate measures such as "user's perception", "technology diffusion", or "dollar capital". "User perception" reflects the perceptual, cognitive or attitudinal responses to the technology (Orlikowski and Iacono, 2001). Therefore, a relevant system measure in this view should include both the "user" and "system" elements. This leads to the need for a "rich" operationalization. "Technology diffusion" reflects the rate of spreading of IT within a social unit but not how it is used or how tasks are performed. Here, only a "very lean" or "lean" measure of system usage would thus be appropriate. Finally, the same logic applies to the capital proxy; once again, only a "very lean" or "lean" measure of system usage could be chosen.

In the third view, that is *ensemble*, the interaction of people and technology could be in the form of a development project, production network, embedded system, or structure (Orlikowski and Iacono, 2001). We argue that since the ensemble view assumes a technology embedded within a complex and dynamic social system to achieve certain goals, a proper measure of the system usage construct from this perspective should comprise all three "system", "task", and "user" elements. This leads to a "very rich" operationalization of the system usage construct.

The fourth perspective focuses on the *computational* capabilities of the systems. Therefore, we argue that the main focus here is on the "system" itself. Thus, only system features and capabilities are generally highlighted in this view and the system usage construct measure should include the "system" element. This leads to a "somewhat rich" structure for the operationalization.

The final perspective is that of the *nominal* view. Akhlaghpour et al (2009, p.3) interpret it as a perspective where "IT artifact is absent […] The conceptual and analytical emphasis is elsewhere; IT artifact is not described, conceptualized or theorized, constituting neither DV [i.e., dependent variable] nor IDV [i.e., independent variable]." We argue that since there are no specific characteristics or dimension of IT described in this view, only a "very lean" or "lean" measure of system usage construct would be appropriate for these studies.

IT Artifact Conceptualization	Very Lean	Lean	Somewhat Rich (IS)	Rich (IS, User)	Rich (IS, Task)	Very Rich (IS, User, Task)
Tool View					✓	
Ensemble View						✓
Proxy View: Perception				✓		
Proxy View: Diffusion	✓	✓				
Proxy View: Capital	✓					
Computational View			✓			
Nominal View	✓	✓				

Table 1-System Usage Measure and IT Artifact Conceptualization

As summarize in Table 1, we suggest that the choice of the structural elements of the system usage construct measure (user, system, and task) is related to the IT artifact conceptualization (nominal, tool, computational, proxy, and ensemble views). We do not claim that this is the only driver of this choice, but we argue that it is an influential one (we discuss the influence of other factors later).

METHOD AND SAMPLE ARTICLES

In order to develop further our research arguments, we conducted an in-depth analysis of selected studies from extant literature. We used the original sample of articles from Akhlaghpour et al (2009) who classified a set of IS papers based on their perspective vis-à-vis the IT artifact. From that sample, we selected the articles that pertain to IS acceptance and usage.

Then, we coded each article to identify how system usage was measured. Finally, we investigated the relationship between the IT artifact perspective and the system usage measure and compared it to our initial arguments. When the observed relationships did not correspond to our arguments, we looked for alternative explanations. The coding process included two steps.

In the first step, we borrowed Akhlaghpour et al (2009) selection of articles from three top IS journals (MISQ, ISR, and JAIS) and used their coding of the IT artifact conceptualization (Orlikowski and Iacono, 2001). This pool of articles included 196 recent articles from 2006 to 2008. A preliminary assessment of these articles showed that 39 articles (19.9%) pertained to the IT acceptance and usage research steam. A second detailed review showed that 12 out of these 39 articles were conceptual papers or did not provide any operationalization of the system usage construct. This led to the exclusion of these 12 articles for a final pool of 27.

In the second step, the first author and an independent coder coded the measures of system usage constructs by assessing their richness, using the three elements proposed by Burton-Jones and Straub (2006). For example, the coders checked whether the article included a measure of the user's status or degree of task accomplishment. Since some of the articles used intention to use as a surrogate for the system usage, we also added this element to our coding. In the first round of coding, an inter-coder agreement of 71.4% was reached. A second round of coding was conducted for the articles for which there was a discrepancy but no agreement was reached. The divergent codes were ultimately arbitrated by the second author of the paper.

RESULTS AND DISCUSSION

Figure 2 illustrates the overall composition of the articles in terms of the system usage measure and the view to IT artifact. Our analysis revealed that in 12 out of the 27 articles (44.4%), "intention to use" was the dependant variable. In IS research, "intention to use" is often explicitly (e.g., McElroy et al., 2007; Komiak and Benbasat, 2006) or implicitly (e.g., Nicolaou and McKnight, 2006; Dinev and Hu, 2007) employed as a surrogate for "system usage". However, there is a gap between the intention to use and the actual use. Since the research questions of some of these articles focused on "system usage" rather than users' intention to use, we argue that these studies would be improved if the system usage construct was included in the models and actually measured.

Table 2 summarizes our analysis of the remaining articles that were included in the final sample (a more detailed summary of our analysis is presented in the Appendix B). Table 2 reveals that there is a correspondence between our analysis of the extant literature and our arguments regarding the relationships between system usage measures and IT artifact perspective in 40% of the sample.

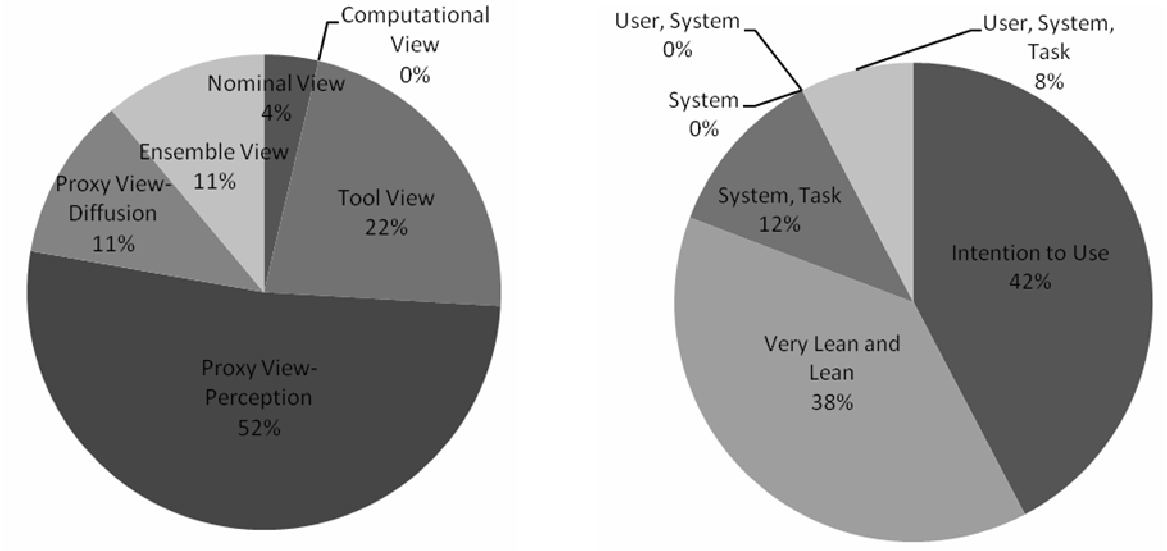

Figure 2.a. Distribution of IT artifact conceptualizations b. Distribution of Type of System Usage Measures

IT Artifact Conceptualization	Very Lean	Lean	Somewhat Rich (IS)	Rich (IS, User)	Rich (IS, Task)	Very Rich (IS, User, Task)
Tool View						
Ensemble View						
Proxy View: Perception						
Proxy View: Diffusion						
Proxy View: Capital						
Computational View						
Nominal View						

Table 2. Summary of the results

Dark-grey shading indicates a correspondence with our arguments;
Light-grey shading indicates at least one instance of discrepancy.

Four studies adopted an IT artifact *tool* view. One used a "very lean" and another, a "lean" measure of usage. The other two included "system" and "task" in their system usage operationalization, which is consistent with our arguments. For example, one of these articles (Mishra et al., 2007) studied the use of Internet in procurement. They included both the variety of "system" features in e-procurement (i.e., finding the product and supplier, order initiation and completion) and also how comprehensive the "task" was performed, which we deem an appropriate measure of use in this context.

Three articles adopted an *ensemble* view of the IT artifact. As per our arguments, two of them included all three elements (user/system/task). One, however, used a "lean" measure of usage. This article (Kane and Alavi, 2008) used a combination of "frequency" and "depth of interaction". According to our previous arguments, the system usage operationalization would have gained by using richer measures, but careful analysis of the research objectives and methodology of this paper showed that considering their research method (i.e., social network analysis) using a "lean" measure was appropriate. The rationale behind this justification is that each respondent in their study had to score both the frequency and depth of interaction for each person s/he interacts with. Therefore, the use of a richer measure would have led to an unmanageable number of questions in the survey instrument.

One study adopted a *diffusion proxy* view of the IT artifact and used a lean measure of usage, which corresponds to our arguments. None adopted a *capital proxy* view of the IT artifact. Seven articles adopted a *perception proxy* view; five of these measured system usage with a "lean" or "very lean" measure. According to our arguments, richer measures comprising "user" and "task" elements would have been more appropriate since a lean operationalization lacks precision about how the actual usage of the system has been performed. In one case however, the number of constructs to be measured was very high, and the choice of using a lean measure may thus be appropriate (Compeau et al., 2007). The two articles that adopted a "rich" usage measure focused on how the tasks were performed using the system rather than what was the emotional or cognitive state of user while using a system. It thus did not correspond to our arguments which suggested a rich measure including the IS and the user elements.

Since no article adopted a *computational* view to IT artifact, we could not develop further our arguments for this perspective.

Finally, one paper adopted a *nominal* view of the IT artifact. Consistent with our proposition, it used a "lean" measure for system usage construct, which corresponds to our arguments. This article (Clark et al., 2007) generally focused on other aspects of management support systems (MSS) rather than on system usage itself. Thus, conceptualizing and measuring MSS usage by the "level of MSS usage" (amount of usage time) seems appropriate in this aspect.

Our analysis of these studies allowed us to refine our arguments. It showed that while the researchers' perspective vis-à-vis the IT artifact might play a key role when researchers chose a system usage measure, other influential factors seem to also play a role in this choice. For example, in the case of Kane and Alavi (2008), we observed that although they adopted an ensemble view to the IT artifact, since the system usage construct is not central in their research, a lean measure was appropriate. This is consistent with Burton-Jones and Straub (2006) who argued that the choice of a measure for the system usage construct is contingent on the objective and method.

Our analysis also revealed that two other factors may be associated with the researcher's decision to choose between lean and rich measures: "system complexity" and "task complexity". If the complexity of the system and tasks is not relatively high, then a lean measure may be a proper measure for system usage. Indeed, in a context where both "task" and "system" are simple, a lean or even very lean measure could be adequate to measure the system usage, even if the IT artifact is viewed

from a tool view. For example, Pavlou and Fygenson (2006) simply tried to see whether the user had used the system "during the last 30 days" (p.139) or not. Since the issue under inquiry in this study was not complex, a lean measure was sufficient.

As indicated in Figure 3, in general, researchers should match their operationalization of system usage with the richness of their perspective vis-à-vis IT. We call this a *balanced* view, whether their choice of usage measure is lean or rich. Choosing between a lean or rich balanced view will also be determined by factors such as the centrality of the usage construct in the research model, the complexity of the task or the system, the total number of constructs under study, etc.

By contrast, when researchers put a significant emphasis on the features of an IT or its social aspects, they may decide to adopt what can be seen as an *unbalanced view.* This will be the case when the researchers have a clear aim to study the features and capabilities of technology (rich view of IT, lean usage measure) or the social attributes of users (lean view of IT, rich usage measure).

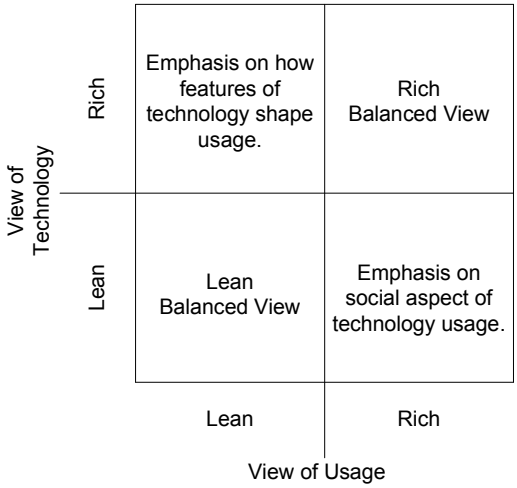

Figure 3. Choosing an Appropriate Usage Measure

CONCLUDING REMARKS AND IMPLICATIONS FOR RESEARCH

This study builds upon the work of Burton-Jones and Straub (2006) and implicitly responds to Barki's (2008) call for better conceptualization and measurement of IS constructs as well as that of Benbasat and Zmud (2003) who argued for considering the IT artifact in IS research. It adds to these studies, showing that a one-size-fits-all conceptualization of the system usage construct is not always appropriate: the richer-the better is not always true. This paper shows how different perspectives vis-à-vis the IT artifact may influence the choice of a given system usage measure: "very rich" measures are not always appropriate and that "very lean" measures are not always inappropriate. We argue that appropriateness depends on the study perspective vis-à-vis the IT artifact, and also on the research objective, theory and context. We further argue that intention to use is not a measure of system usage. Finally, we suggest that IT acceptance and usage researchers may want to consider the matrix we present in Figure 3 when choosing a system usage measure.

This study has some limitations. First, our sample includes a fairly limited number of studies. Though our objective was not to test our arguments but to explore empirically our suggestion, a larger sample of data might have shed more light on the issue. Second, ambiguities in the original studies that were used as our theoretical foundations created some problems in the coding. Indeed, lack of a clear definition for each of the measurement models in Burton-Jones and Straub (2006) created some difficulties in coding of the articles. Akhlaghpour et al (2009) pointed out a similar problem in updating the classification of Orlikowski and Iacono (2001). These issues could be explored in future research.

Despite its limitations, this study offers a number of contributions. It takes a step towards a more systematic selection and/or development of system usage measures, which allows for a better accumulation of knowledge. It also helps expanding further the IS acceptance and use models in the "constantly evolving IT adoption context" (Benbasat and Barki, 2007, p.212).

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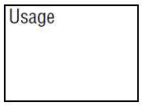
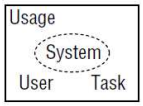
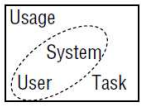
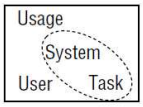
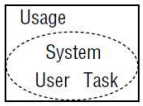
APPENDIX A

Richness of measures	1. Very lean	2. Lean	3. Somewhat rich (IS)	4. Rich (IS, User)	5. Rich (IS, Task)	6. Very rich (IS, User, Task)
Type	Presence of use	Extent of use (omnibus)	Extent to which the system is used	Extent to which the user employs the system	Extent to which the system is used to carry out the task	Extent to which the user employs the system to carry out the task
Domain of content measured*						
Example	Use/nonuse	Duration; extent of use	Breadth of use (number of features)	Cognitive absorption	Variety of use (number of subtasks)	None to date (difficult to capture via a reflective construct)
Reference	Alavi and Henderson (1981)	Venkatesh and Davis (2000)	Saga and Zmud (1994)	Agarwal and Karahanna (2000)	Igbaria et al. (1997)	

*Lean measures reflect usage alone; rich measures reflect its nature, involving the system, user, and/or task.

Table A. Rich and lean measures of system usage. Adopted from Burton-Jones and Straub (2006, p.233, Table 2)

APPENDIX B

Authors	IT Artifact	Intention	Very Lean	Lean	Somewhat Rich (IS)	Rich (IS, User)	Rich (IS, Task)	Very Rich (IS, User, Task)
Arnold et al. (2006)	Tool- Info Processing			x				
Barki (2007)	Ensemble- Structure							x
Burton-Jones & Straub (2006)	Ensemble- Embedded system							x
Clark et al (2007)	Nominal			x				
Compeau et al (2007)	Proxy- Perception		x					
Devaraj et al (2008)	Proxy- Perception						x	
Kamis et al (2008)	Proxy- Perception		x					
Kane & Alavi (2008)	Ensemble- Embedded system			x				
Karahanna et al (2006)	Proxy- Perception						x	
Limayem et al (2007)	Proxy- Perception			x				
Mishra et al (2007)	Tool- Productivity						x	
Pavlou & Fygenson (2006)	Proxy- Perception			x				
Pavlou et al (2007)	Tool- Productivity		x					
Rensel (2006)	Tool- Info Processing						x	
Venkatesh & Ramesh (2006)	Proxy- Diffusion			x				
Venkatesh et al (2008)	Proxy- Perception			x				
Mithas et al. (2008)	Tool-Info Processing	x						
McElroy et al (2007)	Tool-Info Processing	x						
Sheng et al (2008)	Proxy- Diffusion	x						
Schwarz (2007)	Proxy- Diffusion	x						
Bhattacherjee & Sanford (2006)	Proxy- Perception	x						
Dinev & Hu (2007)	Proxy- Perception	x						
Nicolaou & McKnight (2006)	Proxy- Perception	x						
Hsieh et al (2008)	Proxy- Perception	x						
Komiak & Benbasat (2006)	Proxy- Perception	x						
Son et al (2006)	Proxy- Perception	x						
Srite & Karahanna (2006)	Proxy- Perception	x						

Table B. Detailed results. The X marks show the final coding of system measure model for each article. The gray cells show what type of measure we would suggest based on our proposed criteria